2019 Workshop: Concert

Long title
Grand Challenge: Coordinated Ground and Space-based Observations of the Ionosphere-Thermosphere System
Grand Challenge
Conveners
Katelynn Greer
Alan Burns
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Carlos Martinis
Iurii Cherniak
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Description

This workshop provides a forum for the community of investigators studying the thermosphere-ionosphere system of night time phenomena, dayglow variability and the thermospheric thermal structure using coordinated observations from ground- and space-based instruments, including GOLD, ICON and COSMIC-2. Contributions are welcome in the form of brief focused presentations. Of particular interest are investigations combining ground-based and space-based observations, opportunities for campaigns, and/or proposals for coordinated ground- and space-based instruments. The sessions will include time for open discussion assessing progress and discussing future directions.

Agenda

Monday 13:30-15:30 Mesa A

Bruce Fritz (5)

Astrid Maute (8)

Vu Nguyen (8)

Titus Yuan (8)

Mihail Codrescu (8)

Dominic Fuller-Rowell (5)

Iurii Cherniak (12)

Valery Yudin (5)

Jonathan Makela (8)

Tuesday 10:00-12:00 Mesa A

Carlos Martinis (8)

Richard Eastes (12)

Iurii Cherniak (5)

Tom Immel (12)

Quan Gan (5)

Scott England (5)

Larisa Goncharenko(8)

Xugaung Cai (5)

Saurav Aryal (5)

Alan Liu (5)

Loren Chang (5)

Phil Erikson (8)

Justification

Significant challenges in understanding and predicting the thermosphere and ionosphere continue to exist; current models still fall short of properly describing night time phenomena, the variability of day time airglow and the thermal structure of the lower thermosphere. New observations from the GOLD mission have allowed the unambiguous determination of the equatorial ionospheric anomaly (EIA) in space and time, challenging long-held assumptions about the phenomena, including the

decay of the EIA and the formation of depletions (bubbles). The uncharacterized day-to-day variability of the dayglow has been a hot topic of discussion given the strong forcing of waves from the lower atmosphere during this solar minimum. And finally, the highly variable thermal structure of the lower thermosphere must be cross-validated between space-based and ground-based instruments to establish both the weather and climatology of this region.

With the recent launch of the GOLD mission of opportunity (25 January 2018), and the upcoming launches of the ICON and COSMIC-2 spacecraft, both expected to launch during 2019, our community has a unique, perhaps unprecedented opportunity to investigate these questions. These three missions (GOLD, ICON, and COSMIC-2) will provide unique opportunities for probing both the upper neutral atmosphere (optic observations by GOLD and ICON optical instruments) and ionosphere (electron density profiles from the bottom ionosphere border to 500 km altitude by COSMIC-2 radio occultation (RO) as well as in-situ plasma measurements onboard ICON and COSMIC-2 on equatorial an polar planes). With the combination of these observations with the ground-based facilities data (such as ISR’s, ionosondes, GNSS networks, FPIs, lidars, and all-sky cameras), new opportunities for the investigation of coupling processes within the ITM system will be presented. In particular, the combination of COSMIC-2 RO, GOLD, Jicamarca ISR and Julia coherent radars, and ground-based GNSS observations will be a key for understanding of the EIA variability and the formation and evolution of the plasma bubbles. Coordinated ground- and space-based observations will bring more detailed specification of the physical processes in the ITM system, improvement of models, and also improve our understanding of the impact of these processes on performance of critical technological systems that use transionospheric radio links including GNSS. How current theories fit these observations will also be explored.

The wealth of new observations will inevitably catalyze many new findings. However, it is clear that significantly deeper, and perhaps more transformative studies can be performed by combining the new observations with tailored campaigns using existing and upcoming ground-based instrumentation, as well as with new development of first principles models of the coupled ITM system. Such coordinated studies must occur during the lifetimes of these spacecraft missions, but no forum exists in which to plan these. This CEDAR Grand Challenge Workshop will engage a broad spectrum of the observational community and will provide the necessary forum to bring the space- and ground-based observational communities together to

discuss in detail their observed and derived quantities, learn about upcoming operations, propose and plan coordinated campaigns, report back on new findings, and engage the modeling community with these new findings. We will also encourage participation from other interested members of the CEDAR community, who wish to discuss particularly compelling options for campaigns that can be performed. The scientific return of the upcoming missions is expected to have a transformative impact on CEDAR science and the proposed workshop will provide a formal way for the broader CEDAR community to contribute to the mission science, and vice versa.

This workshop directly aligns with Strategic Thrust 3 described in the CEDAR strategic plan: “To understand the transformation and exchange of mass, momentum and energy at transitions within the ITM and through boundaries that connect with the lower atmosphere and the magnetosphere…” Accurate interpretation of night time phenomena and it’s consequence for plasmas in the ionosphere and the lower atmospheric impact on its development (including depletions) address this strategic thrust. Further, understanding how gravity waves, planetary waves and tides impact on the structure and airglow as well as the thermal structure of the lower thermosphere are important considerations within this strategic thrust. Additionally, this workshop will speak to Strategic Thrust 4: “Develop Observational and instrumentation strategies for geospace system studies…. To exploit existing and planned observational assets in order to optimize scientific return. The three geospace missions that have begun or are planned to begin in 2019 represent perhaps the greatest investment in observational assets our community has had in decades. The Grand Challenge proposed here would facilitate the exploitation of these missions, during their lifetimes, by combining them in new and unique ways with ground-based observatories in order to maximize scientific return.

This proposed GC workshop is focused on coordinated observations of the thermosphere-ionosphere system by facilitating the planning of coordinated ground- and space-based observational campaigns, utilizing the upcoming geospace missions, with the goal of providing coordinated observations to the community that would not otherwise be made. The metric for success is whether such campaigns are successfully organized and ultimately conducted, both at the workshop and following each workshop. The workshop provides a forum for sharing what was learned from each campaign, but the primary goal of that activity is to help refine plans for the

following year and present new scientific insights from previous campaigns. At the end of the three years, we will report back on many campaigns were successfully carried out, how many were partially executed, and what was enabled by this activity that would not have otherwise have come to pass (i.e., what observations and scientific findings were gained that would not have occurred through purely routine data collection).

Our organizing team represents CEDAR community members involved in the space-based and ground-based observations of the thermosphere and ionosphere as well as those who have a strong background in the theoretical underpinnings of this region. Through our initial direction, we can work prior to the first workshop to ensure that as much relevant information, including specifics such as planned operations, calibrations, and solicit a wide distribution of community members to attend the workshop with ideas for specific observations and campaigns.

Although the observations and scheduling of both the ground and space-based observatories are largely predetermined, some flexibility exists. For example, the GOLD instrument has 2 channels, one of which can meet its science requirements, allowing the second to be used, at least in-part, for observational campaigns, if sufficient planning in advance is done to generate the observational sequence and upload to the spacecraft. The ICON mission will have some flexibility in its calibration schedule, which could be adjusted based on input from the ground-based community to optimize collocated observations. It is also important to coordinate observing times with ground-based observations that do not operate continuously (i. e., ISRs). Multiple workshops are needed in order to first share this information, learn what can be done, and what can’t; second, have sufficient time to plan and execute coordinated campaigns; and third, to report back on coordinated campaigns and scientific findings. Further, the scientific challenges outlined cannot be fully and adequately addressed by individual instruments, but can by coordinated, well planned space and ground-based observations, with theoretical studies. The scope of the activity is beyond individual regular CEDAR workshop.

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